(12) UK Patent Application (19) GB (11) 2 334 739 (13) A

(43) Date of A Publication 01.09.1999

(21) Application No 9804018.1

(22) Date of Filing 25.02.1998

(71) Applicant(s)
Netlon Limited
(Incorporated in the United Kingdom)
New Wellington Street, BLACKBURN, Lancashire, BB2 4PJ, United Kingdom

(72) Inventor(s)
Robert William Isaac

(74) Agent and/or Address for Service
Marks & Clerk
57-60 Lincoln's Inn Fields, LONDON, WC2A 3LS, United Kingdom

(51) INT CL^6
E02D 17/18 29/02

(52) UK CL (Edition Q)
E1H HJA HJB

(56) Documents Cited
GB 2295180 A EP 0197000 A1 WO 96/33314 A1
US 4798499 A

(58) Field of Search
UK CL (Edition Q) E1H HJA HJB
INT CL^6 E02D
Online: WPI

(54) Abstract Title
A geoengineering construction

(57) In order to make a geoengineering construction, such as an embankment or a bund, layers of fill 2 are placed on layers of reinforcement material 3. The reinforcement material 3 can be a geotextile. The fill material 2 is retained at the face by a geofabric 4. Rigid facing panels or grids 6 are secured against the geofabric 4 by securing means 5,7 which are connected to the reinforcement layers 3. Various embodiments of securing means are supplied. Before completion of the construction, the facing panels 6 are removed by cutting the securing means 5. When the construction is complete the geofabric 4 retains the fill material 2 at the face.

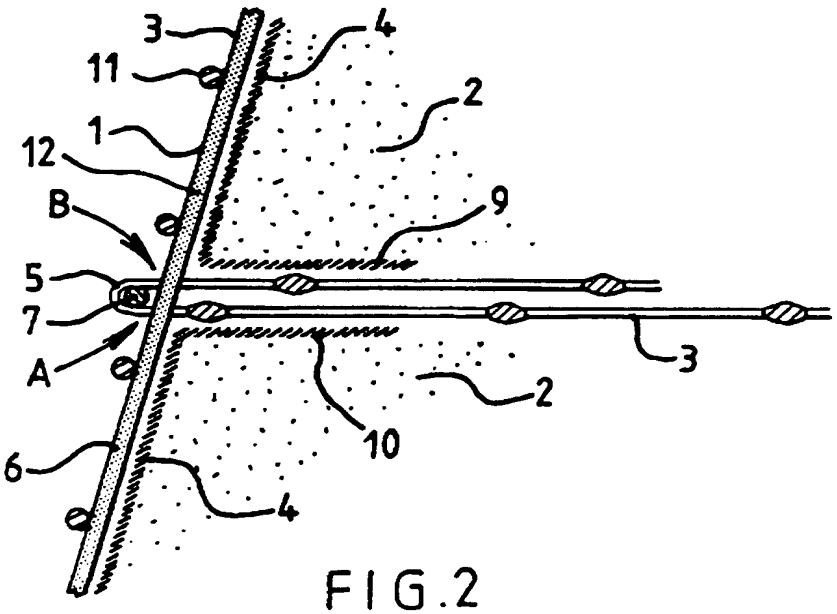

FIG.2

GB 2 334 739 A

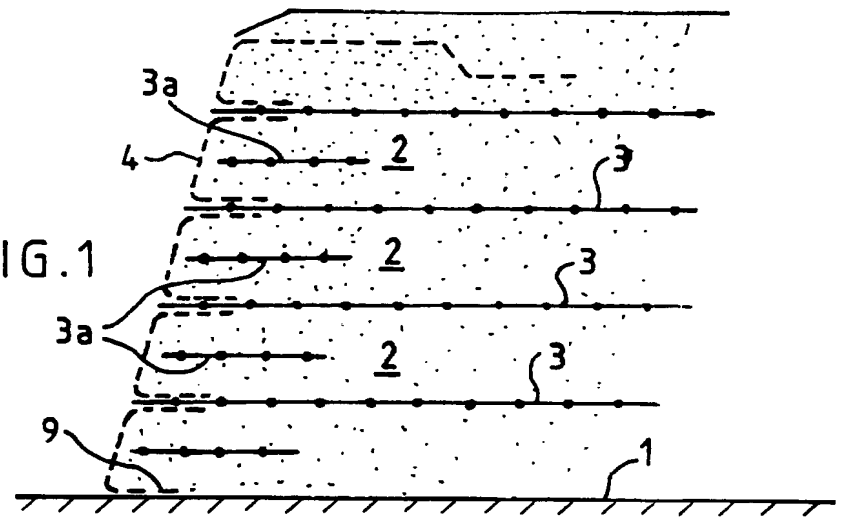

FIG.1

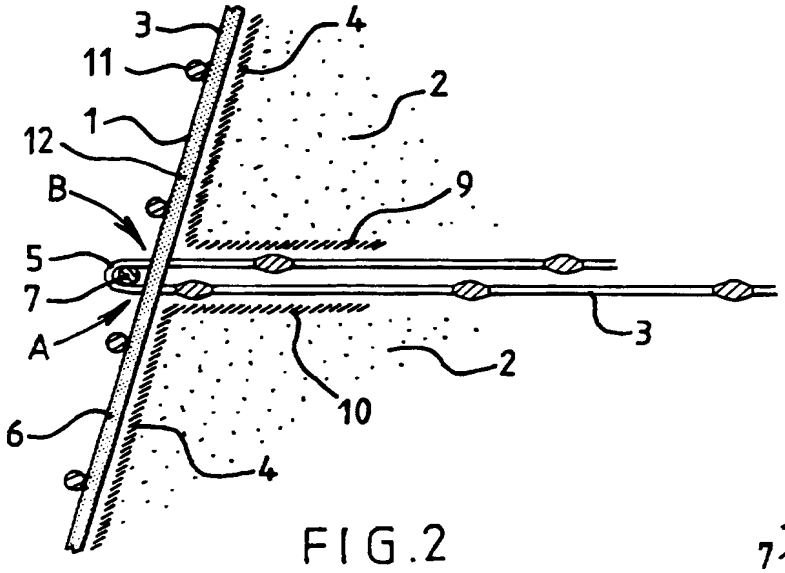

FIG.2

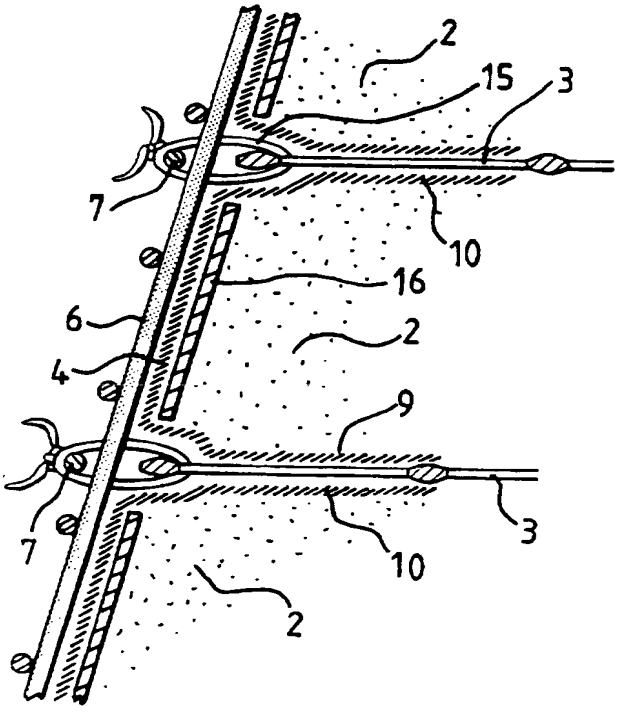

FIG.3

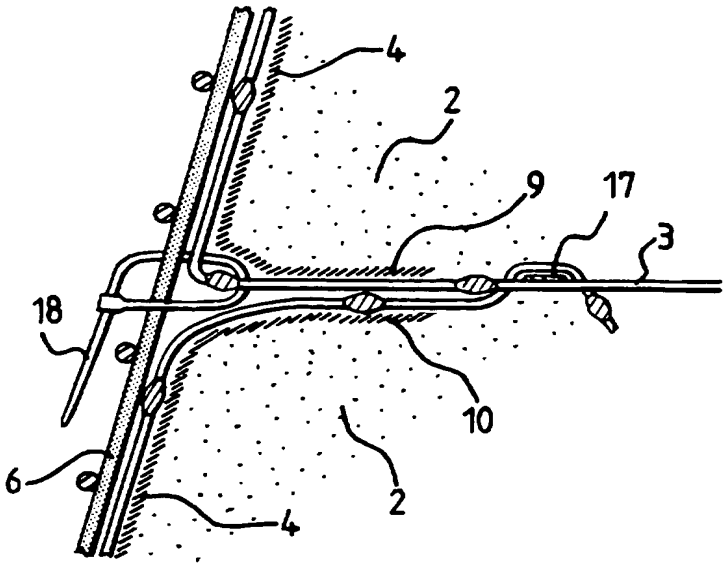

FIG. 4

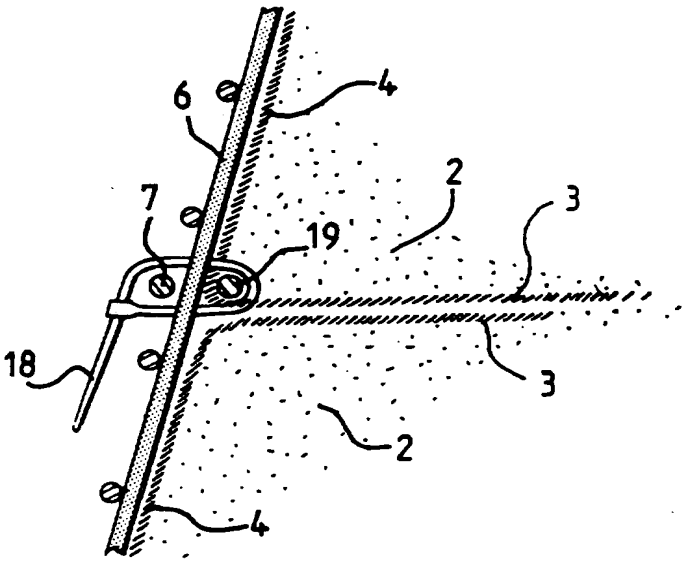

FIG. 5

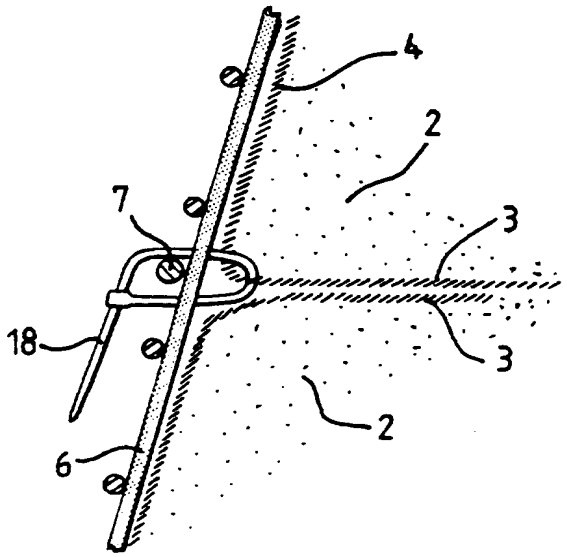

FIG. 6

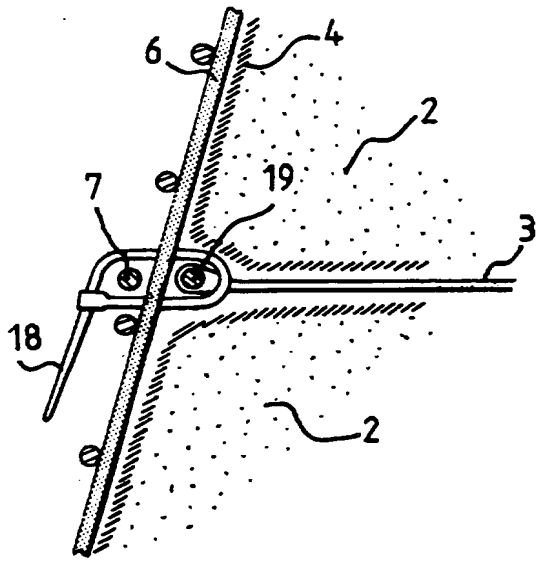

FIG. 7

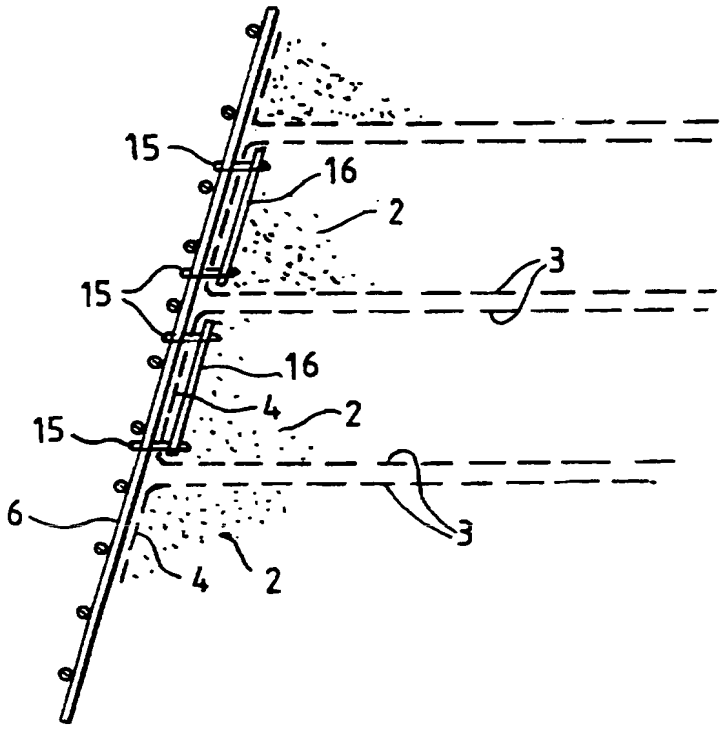

FIG. 8

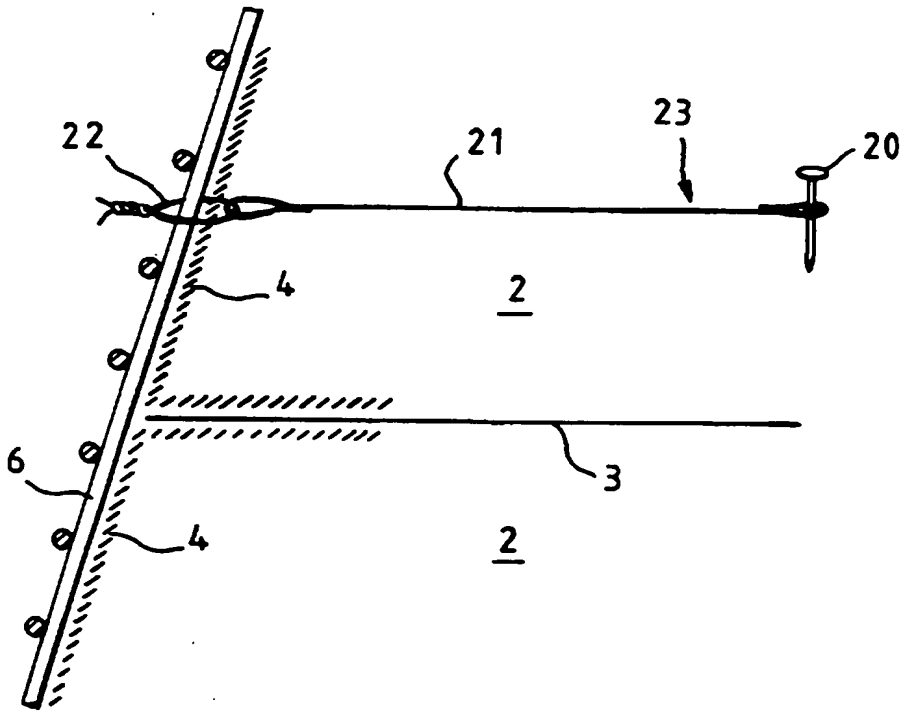

FIG. 9

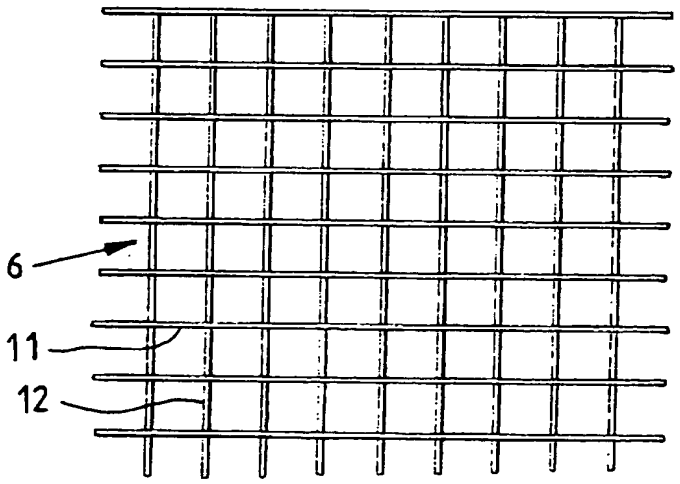

FIG. 10

2334739

Document #: 215913

M&C Folio: 230P78104

Amended 98.02.23

Making a Geoengineering Construction

Background to the Invention

The present invention relates to a method of making a geoengineering construction having a face, comprising placing layers of fill with layers of reinforcement between the layers of fill. One such geoengineering construction is shown in Figure 14 of US 4 374 798 and another such geoengineering construction is shown in EP 0 197 000A. The reinforcement can be of any suitable type, but modern practice is to use plastics geogrids as disclosed in US 4 374 798. The fill (which may be referred to as soil) can be rocks, stones, gravel, sand, earth, clay, aggregate held by a binder such as asphalt, or any other particulate or cohesive material used in geotechnical engineering. In making a geoengineering construction of this type, it is normal practice to consolidate after each layer of fill is placed, unless the fill is such that full compaction is achieved on dumping the fill. The layers of fill can for instance be 150 to 500 mm thick or even up to 1 m or more thick if local practice permits this. When a steep ground slope is produced, for instance a ground slope having a face angle above say 45° to the horizontal, it is usually necessary to face it in order to retain the fill.

The Invention

The invention provides a method as set forth in Claim 1, 5 or 21 and a geoengineering construction as set forth in Claim 20 or 22. The remaining claims claim preferred or optional features of the invention.

In broad outline, the fill at the face is retained by fill retaining means and the fill retaining means are in their turn retained by substantially rigid facing panels which during construction are secured at a level above the bases of the panels to anchors in the

fill. The facing panels are deliberately removed before completion of the construction as part of making the geoengineering construction, as opposed to the long term degradation and disintegration which can occur with facing panels which are left in position. When the facing panels have been removed, the face will be formed by the fill retaining means. The construction can be of any suitable height and may be built in stages.

There can be at least one position of restraint or an actual anchor line (which provides a horizontal component of force) at an intermediate level up the height of the facing panel in that there is at that position (ie substantially above the base of the facing panel) a connection passing through the fill securing the facing panel to the anchor in the fill, the (substantially straight) line of force passing through the fill and said position; thus, the facing panel can be secured to the anchor by one or more connections to the facing panel at a position or positions on the facing panel which are substantially above the base of the facing panel. A connecting element used for securing the facing panels to the anchor extends directly behind the connecting position or positions on the facing panel, and the major part of the connecting element can be behind the facing panel. The connecting element (or the substantially straight line of force from the connection position on the panel to the anchor) can be generally horizontal but need not necessarily be so.

The facing panels are preferably "positively secured", which means secured by mechanically interengaging members on a macro scale rather than by friction, e.g. by looping around or tying. In order to provide a simple and efficacious arrangement, the panels can be secured to the reinforcement preferably at a position on the reinforcement which is adjacent the face of the structure.

The invention can be useful for supporting an impervious membrane at the face, eg to form the side-walls of a waste management or disposal pit, because a facing can be provided which has no sharp projections which would puncture or cut the membrane. An impervious membrane can be hung down the face when a stage has been completed

and the facing panels removed, and can be sealed (for instance by hot-welding or adhesive) to the membrane hung down over a lower stage.

The invention can be useful for providing stop butts on firing ranges or blast walls or barriers around explosives stores as there need be no steel or concrete in the construction of the invention that could generate shrapnel and the facing can absorb projectiles without danger of ricochet; for instance the construction could be made from just sand and thermoplastic polymeric components.

The invention can be useful for ordinary embankments. Once the facing panels have been removed, normal covering techniques can be used. If the face is to be vegetated, eg being a steep embankment or noise control bund for a road, the fill retaining sheets need to be porous to allow penetration by roots into the fill or soil or vegetation from the soil, the invention being advantageous in this application as the vegetated face may contain no metallic elements that could damage mechanical vegetation cutters.

Normally, the facing panels will be re-used when making the same geoengineering construction, for instance being removed when a section of the construction is finished and being used when making the next-but-one section of the construction in the horizontal sense or in the vertical sense; an advantage of the invention is that the slope face can be readily constructed in stages using a small number of facing panels which are moved from a completed area to a new area as the construction progresses. Another advantage of the invention is that as only a relatively small number of facing panels need be used, they may be of a heavy gauge so as to ensure that the correct surface profile is maintained, without adding significantly to the project cost. Thus specifically, if the facing panels are grids, they can be constructed from 10 mm diameter steel rod. A further advantage of the invention is that the facing panels need no form work or special bracing and can be flat and stackable for transport and storage both on and off site.

It is a normal construction technique to provide angle bars at the base of a face to hold facing panels at the correct inclination, which facing panels retain the face of the first layer of fill. As the facing panels of the invention are anchored or tied back, the angle bars need not be especially strong and can thus be cheaper. Also, they can be pulled out after they have served their purpose, and be re-used.

The facing panels can be of any suitable type, but must be sufficiently rigid to prevent excessive bulging of the fill retaining means. Facing panels formed of metal grid or mesh can provide an effectively smooth face and easy construction. The meshes are preferably substantially square or rectangular and the panels themselves can be substantially square. In one preferred arrangement, the facing panels comprise horizontal members secured to vertical members with the horizontal members outermost and the lowermost parts of the vertical members projecting below the lowermost horizontal member. With such panels, the method can include placing the lowermost parts of the vertical members behind the top horizontal member of a lower facing panel in order to place the upper facing panel, thus providing a good interlock to give horizontal restraint to the base of the facing panel, and also providing an effectively smooth face behind the panels. Another advantage of such facing panels is that if the ground is suitable, the projecting lowermost parts of the bottom panels can be spiked into the ground to support the first layer of fill and give horizontal restraint to the base of the facing panel, without requiring special measures such as the angle bars referred to above. Nonetheless, even if the lowermost parts of the vertical members do not project, horizontal restraint can be given to an upper panel by inserting its lower part behind the upper part of a panel immediately below - normally, there should be some restraint at the bases of the facing panels. Other methods are available for providing horizontal restraint to the bases of the facing panels, for instance by securing them to anchors in the fill. The horizontal members can project beyond the outer vertical members, to interlock with horizontally adjacent panels.

The anchors in the fill can be of any suitable type. For instance, anchor members, e.g. generally vertical members such as pins or pegs, can be driven into the fill say a metre

back from the face and the facing panels tied back to the anchor members say with ropes; although the bottom of the anchor member may penetrate below the level of the bottom of the facing panel, the position of connection to the facing panel itself can be at a level substantially above the bases of the facing panels, and the position of connection to the anchor can also or alternatively be at a level substantially above the bases of the facing panels. However, the anchors are preferably reinforcement for reinforcing the fill, e.g. in the form of layers or in the form of strips e.g. of steel, polymer or glass-reinforced composite. The facing panels can be secured to the reinforcement in any suitable manner. For instance, if the reinforcement is a geogrid with sufficiently long apertures, the geogrid can be bent back through 180° at the face and the loops so formed inserted through openings in the facing panel and a horizontal member rod passed through the loops on the outside of the facing panel, the loops then forming connecting elements. In order to remove the facing panel, the loops can be cut. This may not be satisfactory if for instance an impermeable membrane is to lie against the face because the cut ends of the reinforcement may be sharp enough to pierce the membrane. In such circumstances, detachable connecting elements or ties such as braid, cable ties, wire (eg. twisted wire) or sewing can be used, and these are suitable for use not only with geogrid reinforcement but also with reinforcement such as galvanised mesh panels or geotextiles (in the latter case, eyelets or sewn loops or "button holes" can be provided along the edges of the geotextile adjacent the face) or strips (where the ties can be passed through holes adjacent the ends of the strips). The ties can be tied to vertical members of a grid facing panel, to permit some settlement during construction.

The preferred reinforcement is an integral geogrid, but the invention will work with any form of geogrid; preferably there is sufficient junction strength between transverse and longitudinal elements of the geogrid for a connection from a transverse element to the facing panels to be able to hold the facing panels in position during construction, but this depends upon the arrangement for securing the facing panels to the reinforcement. Steel mesh, woven or knitted geogrids without high junction strengths and simple plain geotextiles can be used as reinforcement, and the geosynthetic which is taken up behind

the facing panel as the fill retaining means can also provide the reinforcement. Thus, if the reinforcement itself is suitable, it can be for instance looped back around a bar immediately behind the facing panel, or taken around the bar or other anchoring means and up the rear of the facing panel, or be held to the facing panel by braid, cable ties, wire or sewing.

The fill retaining means are preferably water pervious. They can be of any suitable nature, even layers of turf; however, they are preferably of flexible sheet-like form and can be geosynthetics, for instance a fine plastics mesh or preferably a geotextile or a pre-seeded or pre-vegetated mat. The fill retaining means can be secured top and bottom in any suitable manner. For instance, if a respective fill retaining sheet is separate from the reinforcement, the bottom of the fill retaining sheet may be secured by placing a bottom portion of the sheet on the fill or on the reinforcement before placing the respective layer of fill so that the fill retaining sheet comprises a generally L-shape as seen in section normal to the face; similarly, the top of a fill retaining sheet may be secured by placing a top portion of the sheet on top of the respective layer of fill so that the fill retaining sheet comprises a generally inverted L-shape as seen in section normal to the face; if both these methods are used, the fill retaining sheet will adopt a generally C-shape as seen in section normal to the face. If these methods are used, the fill retaining sheet will normally not extend very far back into the construction, extending back far enough merely to anchor the fill retaining sheet in position. However, as an alternative, the fill retaining sheet can be secured to or integral with the reinforcement, either at its top or at its bottom or at both locations.

The face may have a significant angle, say between 50° and 65° to the horizontal, and normally be stable without any further provisions required, provided that a fill of appropriate properties is used. However, if the angle is steeper or fill of inadequate properties is used, the face could slump, the fill retaining means bulging out between each layer of reinforcement if geosynthetics are used for the fill retaining means. Slumping can be avoided by placing stiffening panels behind the geosynthetic fill retaining sheets - such stiffening panels can be of for instance plywood, chipboard,

metal mesh or concrete, and can be of rectangular shape with the long axis horizontal, eg plank like. During construction, the stiffening panels can be put in position after the fill retaining sheet has been put behind the facing panel.

The steps of the method need not necessarily take place in the order listed, if it is practicable to have a different order. For instance, the bottom portion of the fill retaining means is preferably placed immediately above the layer of reinforcement, but it could be placed immediately on the layer of fill with the layer of reinforcement placed above the bottom portion or both bottom and top portions may be at different levels in the construction to that of the reinforcement. Furthermore, other steps can be effected between those listed. For instance, relatively short layers of reinforcement say about ½, 1 or 2 metres long, can be inserted between the main layers of reinforcement and not secured to the facing panels, to prevent slumping.

The Drawings

The invention will be further described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a schematic vertical section through a geoengineering construction made in accordance with the invention;

Figures 2 to 9 are scrap vertical sections through six geoengineering constructions in accordance with the invention showing different methods of construction; and

Figure 10 is a view of an example of a facing panel used in the method illustrated in Figures 2 to 9.

Figure 1

Figure 1 illustrates the finished construction once the facing panels have been removed, and shows the ground 1, layers of fill 2 with layers of reinforcement 3 between the layers of fill, and fill retaining liners 4 of geosynthetic sheet retaining the fill 2 at the face. Optionally, layers of reinforcement 3a can be inserted between the layers 3, to

prevent slumping, and a layer 3 can be placed directly on the ground 1 (not shown). The layers 3a can be stronger or less strong than the layers 3 and can be shorter than (as shown), the same length as or longer than the layers 3.

Figure 2

Figure 2 shows a construction in which the layers of reinforcement 3 are plastics geogrids as disclosed in US 4 374 798. At the face, they are bent back through 180°, the loops 5 so formed (which act as horizontal connecting elements) are inserted through openings in a facing panel 6, and a horizontal rod, for example 12 or 15 mm diameter steel rod 7, is passed through the loops 5 on the outside of the facing panel 6 in order positively to secure the facing panel 6 to the reinforcement 3 at the face of the structure. In this way, the reinforcement 3 acts as an anchor and there is at a level above the base of the facing panel 6 a connection securing the facing panel 6 to the reinforcement 3 which extends directly behind the facing panel 6 and provides a substantially straight, horizontal line of force from the connection position on the facing panel 6 to the anchor. Normally, there will be two or more layers of reinforcement 3 (say up to three or four per metre height) secured to each facing panel 6 in this manner. Behind the facing panel 6 is placed a geosynthetic liner 4 of generally C-shape as seen in vertical section normal to the face (i.e. an upper generally inverted L-shape merging with a lower generally L-shape), having a bottom portion 9 resting on the ground 1 or on the reinforcement 3 and secured in position by frictional contact with the reinforcement 3 below and the weight of fill 2 above, and a top portion 10 folded back onto the top of the respective layer of fill 2 so that it is secured in position by frictional contact with the fill 2 below and the reinforcement 3 above.

As shown in Figure 10, the facing panel 6 is a welded grid or mesh formed of horizontal bars 11 and vertical bars 12 eg of 10 mm diameter steel, with the horizontal bars 11 on the outside. The lowermost parts of the vertical bars 12 project below the lowermost horizontal bar 11 and the horizontal bars 11 project beyond the outer vertical bars 12 on each side. The panels can for instance be a 2.4 m x 2.4 m square.

A construction sequence can be:

1. Prepare a level foundation.

2. Place a row of panels 6 in a standing position, with the projecting ends of the horizontal bars 11 intermeshing. This can be done in any suitable manner, for instance by spiking the lower ends of the vertical bars 12 into the ground or by propping or by using temporary guy ropes and pegs. If desired, a layer of reinforcement can be placed on the ground 1.

3. Place a geotextile liner 4 behind the panels 6 with the bottom portion 9 of the liner 4 (see Figure 1) resting on the ground 1 (there should be a lap of a minimum length of 200 mm) and the top portion 10 of the liner is held in position against the panels 6 or if it is high enough, folded outwards over the top of the panels 6. The geotextile liner 4 can be for instance a Netlon R1204 geotextile available from Netlon Ltd.

4. Lay and compact the initial layer of granular fill 2 such as sand.

5. Fold the top portion 10 of the liner 4 over the top of the first layer of fill 2 - there should be a lap of a minimum length of 200 mm.

6. Position the first layer of reinforcement 3 (or second layer if a layer was placed on the ground), including securing it to the panels 6 using a 12 to 15 mm diameter steel bar 7, side-by-side lengths of reinforcement 3 being butted against each other along their edges. This arrangement permits some vertical settlements as the bar 7 slides down the vertical bars 12. The reinforcement 3 can be for instance Tensar 80RE geogrid available from Netlon Ltd.

7. Tension the free end of the reinforcement 3, to take out slack.

8. Whilst maintaining tension, place enough fill 2 on the reinforcement 3 to hold the reinforcement 3 in position.

9. Release the tension.

10. Complete the layer of fill 2, and compact.

11. Repeat steps (6) to (10) until the respective layer of fill is near the top of the panels 6.

12. Place another layer of panels 6 in position by inserting the lower ends of their vertical rods 12 behind the tops of the first row of panels 6 - if necessary, props or guy ropes can be used to maintain the correct position of the panels 6.

13. Continue placing fill etc as in steps (6) to (10) above.

14. When the upper row of panels has been secured to preferably at least two layers of reinforcement 3, cut the loops 5 holding the lowermost row of panels 6 to the reinforcement 3 at point A and/or point B so as to release the loose, transverse, horizontal bars 7 and release the respective panels 6.

15. Pull the panels 6 up out of the ground for re-use.

An alternative to steps (14) and (15) is to complete one section of the construction right to the top before removing the panels 6.

Figure 3

Figure 3 illustrates two possible variations of Figure 2. The first variation is used if the slope face is to support a membrane and the cut ends of the reinforcement 3 could puncture the membrane. In this case, the reinforcement 3 terminates just behind the panel 6 and the transverse bar 7 is tied to the reinforcement 3 with braid 15 which either

may be sufficiently soft to cause no damage to a membrane, or may be removed completely after cutting. In this manner, although the knot in the braid 15 relies on friction, the panel 6 is positively secured to the reinforcement 3 at a position on the reinforcement 3 which is immediately adjacent the face of the structure. In this case, the reinforcement 3 could be a galvanised steel mesh panel.

In the second variation, which is used where the use of a fabric retainer 8 alone is insufficient to prevent unacceptable bulges in the face, panels 16 are placed behind the retainers 4, thereby providing a flatter surface to the slope. The panels 16 can be plank-like and made of for instance plywood or chip-board, or can be steel mesh panels.

Figure 4

Figure 4 illustrates a variation where each layer of reinforcement 3 is taken up the face and then back over the top of the respective layer of fill 2 and secured to the next layer of reinforcement 3 by pushing loops up through the meshes in the reinforcement 3 and inserting a pin 17 through the loops, as disclosed in US 4 530 622. This type of construction is referred to as a wrap-around structure.

Figure 4 also illustrates another variation in that a self-locking cable tie 18, eg from Hellerman Insuloid, is used instead of the braid tie, to secure the panel 6 positively to the reinforcement 3.

As a further variation, the braid tie 15 or the cable tie 18 of Figures 3 and 4 is shown without a horizontal bar 7, tying the reinforcement 3 directly to the vertical bars 12 of the panel 6, which permits some settlement during construction.

Figure 5

Figure 5 illustrates another variation where instead of having a separate reinforcement 3 and liner 4, the reinforcement 3 is taken up behind the panel 6 to act as a liner 4, the reinforcement 3 being of suitably small mesh size to retain the fill 2. The face panel 6

is positively secured to the reinforcement by means of cable ties 18 looped around a horizontal bar 19 placed behind the reinforcement 3 and a horizontal bar 7 in front of the face panel 6. The ties 18 pass through the reinforcement 3.

Figure 6

Figure 6 illustrates that the bar 19 can be omitted if a braid tie, a wire, stitching or (as shown) a cable tie 18 is pushed through the reinforcement 3 and can catch enough warp or weft yarns, or strands in general, of the reinforcement 3 to carry the load required to hold the face in position, thereby positively securing the panel 6 to the reinforcement 3 at a position on the reinforcement 3 which is immediately adjacent the face of the structure.

Figure 7

Figure 7 illustrates a variation where the reinforcement 3 is a woven or knitted fabric geogrid without high junction strength, or even a simple plain geotextile. Figure 7 shows the reinforcement 3 looped back around a bar 19, a braid tie, a wire or (as shown) a cable tie 18 being pushed through the fabric of the reinforcement 3 and around the bar 19 so that the bar 19 positively secures the reinforcement 3 to the panel 6 at a position on the reinforcement 3 which is immediately adjacent the face of the structure.

As a further variation, the bar 19 could be omitted provided the ties 18 caught sufficient warp/weft yarns of the fabric reinforcement 3 to carry the load required to hold the face in position.

Figure 8

Figure 8 illustrates a variation of Figure 5 where the bar 19 of Figure 5 has been replaced by a panel 16 (see Figure 3) which may be secured to the facing panel 6 by ties

15 secured direct to the facing panel 6 at a single level or (as shown) at two levels, or alternatively secured to a loose transverse bar 7 as shown for instance in Figure 2. If necessary, holes can be provided in the panel 16 for the ties 15.

Figure 9

Figure 9 illustrates a variation where the facing panels 6 are not held in place by the reinforcement 3 but by anchors in the form of pins 20 driven into the fill, the facing panel 6 being positively secured to the pins 20 by an anchor line 21 and a twisted wire tie 22. However, any suitable fastening which is removable or disconnectable may be used, including tying the anchor line 21 direct to the facing panel 6. As another variation, the anchor assembly 23 (items 20, 21 and 22) may be provided as a one-piece article of suitable shape. The anchor assembly 23 may be at any suitable height in the construction, including immediately above or below a layer of reinforcement 3 or sandwiched between two fill retaining means 4. Also, the anchor line 21 need not be horizontal.

* * * * * * *

The present invention has been described above purely by way of example, and modifications can be made within the spirit of the invention, which extends to equivalents of the features described. The invention also consists in any individual features described or implicit herein or shown or implicit in the drawings or any combination of any such features or any generalisation of any such features or combination.

CLAIMS:

1. A method of making a geoengineering construction having a face, comprising placing layers of fill with layers of reinforcement between the layers of fill, the fill being retained at the face by fill retaining means and by substantially rigid facing panels outside the fill retaining means, which facing panels are secured at a level above the bases of the facing panels to anchors in the fill and which facing panels hold the fill retaining means generally in position during construction, and removing the facing panels before completion of the construction so that the fill retaining means retain the fill at the face of the construction.

2. The method of Claim 1, wherein connections from positions on the facing panels to the anchors extend generally horizontally back into the fill.

3. The method of Claim 1, where the anchors are formed by the reinforcement.

4. The method Claim 1, wherein the anchors are anchor members driven into the soil.

5. A method of making a geoengineering construction having a face, comprising:

placing a substantially rigid facing panel;

placing fill retaining means behind the facing panel;

placing a layer of fill behind the fill retaining means;

placing an anchor in or on the fill;

securing the facing panel to the anchor;

if necessary, placing another fill retaining means behind the facing panel;

placing another layer of fill behind the fill retaining means and above the anchor while the facing panel retains the fill retaining means and the fill in position at the face; and

removing the facing panel before the completion of the construction so that the fill retaining means retain the fill at the face of the construction.

6. The method of Claim 5, wherein the anchor is reinforcement extending back from the face.

7. The method of Claim 6, comprising:

placing another facing panel above the level of the first-mentioned facing panel;

placing a fill retaining means behind the second-mentioned facing panel;

placing another anchor in or on the fill;

securing the facing panel to the anchor; and

placing another layer of fill above the first-mentioned layer of fill and above the second-mentioned anchor while the second-mentioned facing panel, anchored back by the second-mentioned anchor, retains the fill retaining means and the fill in position at the face.

8. The method of Claim 5, wherein the anchors are anchor members driven into the fill.

9. The method of any of the preceding Claims, wherein the facing panels are positively secured to the anchors.

10. The method of any of the preceding Claims, wherein the facing panels are re-used when making the same geoengineering construction.

11. The method of any of the preceding Claims, wherein the facing panels are grids or meshes.

12. The method of Claim 11, wherein the facing panels comprise horizontal members secured to vertical members with the horizontal members outermost and the lowermost parts of the vertical members projecting below the lowermost horizontal member, the method including placing the lowermost parts of the vertical members of an upper facing panel behind the top horizontal member of a lower facing panel in order to place the upper facing panel.

13. The method of any of the preceding Claims, wherein the anchors are secured to the facing panels using ties.

14. The method of any of the preceding Claims, wherein the fill retaining means are sheet-like and the top of the respective fill retaining means is secured by placing a top portion of the fill retaining means on top of the respective layer of fill or reinforcement or anchor so that the fill retaining means comprises a generally inverted L-shape as seen in section normal to the face.

15. The method of any of Claims 1 to 13, wherein the respective fill retaining means are sheet-like and are separate from the reinforcement, and the bottom of the fill retaining means is secured by placing a bottom portion of the fill retaining means on the fill or on the reinforcement or anchor before placing the respective layer of fill so that the fill retaining means comprises a generally L-shape as seen in section normal to the face.

16. The method of any of Claims 1 to 13, and being in accordance with both Claim 14 and Claim 15 so that the fill retaining means assume a generally C-shape as seen in section normal to the face.

17. The method of any of the preceding Claims, wherein the bottom and/or the top of the fill retaining means is positively secured to or integral with reinforcement reinforcing the fill.

18. The method of any of Claims 1 to 16, wherein the bottom and/or the top of the fill retaining means is secured by friction to reinforcement reinforcing the fill.

19. The method of any of the preceding Claims, wherein rigid panels are placed behind the fill retaining means.

20. A geoengineering construction which has been made by the method of any of the preceding Claims.

21. A method of making a geoengineering structure, substantially as herein described with reference to any of Figures 2 to 9 of the accompanying drawings.

22. A geoengineering construction, substantially as herein described with reference to any of Figures 2 to 9 of the accompanying drawings.

23. The geoengineering construction of Claim 20 or 22, and supporting an impervious membrane at the face.

24. The geoengineering construction of Claim 20 or 22, and being a stop butt.

25. The geoengineering construction of Claim 20 or 22, and being a blast wall.

26. The geoengineering construction of Claim 20 or 22, and being a vegetated embankment.

The Patent Office

18

Application No: GB 9804018.1
Claims searched: 1-26

Examiner: Brendan Churchill
Date of search: 10 February 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): E1H (HJA, HJB)

Int Cl (Ed.6): E02D

Other: Online: WPIL

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2295180 A	(Société Civile des Brevets Henri Vidal)	-
A	EP 0197000 A1	(Fritz Landolt AG)	-
A	WO 96/33314 A1	(Fjerby A/S)	-
A	US 4798499 A	(Kensetsukiso Engineering Co., Ltd.)	-

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.